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PATENTS LAW, 5727-1967

בקשה לפטנט
Application For Patent

לשימוש הלשכה
For Office Use

מספר: Number	151748
תאריך: Date	12-09-2002
הוקדם/נדחה: Ante/Post-dated	

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I, (Name and address of applicant, and in case of body corporate-place of incorporation)

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Fluid metering method and system

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* בקשת חלוקה Application of Division	* בקשת פטנט מוסף Appl. for Patent of Addition	* דרישת דין קדימה Priority Claim		
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התקן ושיטה למדידת זרימה

Fluid metering method and system

ARAN Research & Development Ltd.

ארן מחקר ופיתוח בע"מ

C. 140261

FLUID METERING METHOD AND SYSTEM

FIELD OF THE INVENTION

This invention relates to a method, a system and a device for metering fluid flow. More particularly the invention is concerned with a method rendering a conventional fluid meter suitable for metering also significantly low flow rates, even below the measurable flow rate of the metering device. The invention is further concerned with a fluid flow measuring system and a device useful for carrying out the method.

BACKGROUND OF THE INVENTION

The measurement and monitoring of low volume fluid flows has various applications including applications in industrial and residential settings. For example, in the chemical industry the accurate and precise knowledge of inlet and outlet flows for a myriad of processes (e.g. chemical reactions) can be critical to the optimal production and processing of chemicals, pharmaceuticals and the like. Precise monitoring of flows can also be used to discover and prevent leaks which can be costly and be a safety issue.

Additionally, the lack of low-flow monitoring can result in losses to the suppliers of such flow. For example, water companies are compensated for water usage as measured by their flow monitors (water meters). If their flow monitors do not measure trickle or drip flow, they are not reimbursed for such usage. The loss of revenue can be considerable. Additionally, the location of the loss is not detected thereby allowing a large amount of water to be wasted. This is particularly an issue in the many countries with limited water supplies. Furthermore the

knowledge of this monitoring limitation can be used to steal water, for example by slowly dripping water into a holding tank, at a rater not measurable by the associated flow meter, and consuming the water directly from the tank.

Turbine flow meters, which are the conventional magnetic flow meters in general use today have long been used to measure fluid flow by means of a turbine immersed in the fluid. A magnet connected to the turbine turns a second magnet, which is placed in a dry area. The second magnet drives a cog system that turns a mechanical counter. These flow meters are unable to detect low flows e.g. below about 10 l/h when considering a typical water meter of the type installed by water supply companies and municipalities world wide. Positive displacement metering devices are also commonly used to measure flow rate and they have deficiencies in particular where water is of pour quality i.e. containing dirt such as sand and of high calcium content.

Other types of flow meters are also known, some of which are devices for measuring low volumetric fluid flow. However such meters are typically costly, require servicing and are difficult to retrofit, thus are usually not used for domestic water metering.

Droplet counter devices are also known, wherein a sensor is provided for droplet count. However, such devices usually serve for laboratories and are not cost-effective in massive installation, e.g. for use by a water supply company, certainly not for urban use. Even more so, such systems are not easily retrofitted and they require some considerable space.

For example, disclosed in U.S. Patent No. 5,218,346 to Meixler is a low volume flow meter for determining if a fluid flow meets a minimum threshold level of flow. The monitor includes an externally located electrical portion, which operates with a minimum of intrusion to the flow and allows for repairs. The electronics provide for the adjustment of the threshold level and can be modified to provide for a parallel electronic circuit for a bracketing of the desired flow rate. However, the system is not simple or inexpensive.

Another type of flow rate device that has the capacity to measure or monitor a low flow rate is a compound meter. In this case, the device comprises a high flow metering device together with a secondary flow meter that is typically located in a by-pass conduit. There is typically some means for diverting flow (e.g. by using a *"change-over"* valve) based set to activate at a pre-determined pressure) based on a pre-determined flow rate or pressure in order to direct the flow to the appropriate meter. These meters typically suffer from at least some of the above-mentioned drawbacks and in particular are expensive.

SUMMARY OF THE INVENTION

According to the invention there is provided a fluid supply system comprising a supply line and flow metering device and a flow responsive valve; said pressure metering device admitting flow through the system for only measurable fluid flow.

The arrangement is such that when flow rate exceeds a minimal measurable flow rate threshold the valve is open owing to a pressure differential over its inlet port and outlet port; and when the flow rate drops below said minimal measurable flow rate threshold, the valve enters a pulsating position having a closed state thereby substantially restricting flow through the system, and an open state allowing fluid flow into the system; said open state having a flow rate exceeding the minimal measurable flow rate threshold; where portions of the supply line downstream of the flow meter and devices fitted thereon function as a fluid accumulator.

According to the invention, an average fluid flow through the system remains constant over time, whereby a consumer downstream of said metering device does not acknowledge flow rate fluctuations imparted by the system according to the present invention.

According to the invention, there is a fluid metering system comprising a fluid supply line and a meter for measuring fluid flow therethrough, said meter having a minimum measuring flow threshold; the system further comprising a flow

responsive valve imparting the system with a flow pattern having a pulsating character so as to substantially prohibit flow at a flow rate below the minimum measuring threshold, and resume flow of only measurable quantities of fluid. The flow responsive valve is in fact responsive to flow rate and to pressure differential extending between an inlet and an outlet of the valve.

According to another aspect the present invention is concerned with a method for metering fluid flow through a fluid supply line comprising a flow meter having a minimum measurable threshold and a flow responsive valve imparting a flow pattern therethrough with a pulsating character so as to substantially restrict flow at a flow rate below the minimum measuring threshold, and resume flow of only measurable quantities of fluid. The arrangement is such that the fluid supply line and any devices fitted thereon function as an accumulator, whereby at an open state of the flow responsive valve, during its open phase, fluid accumulate sin the system.

The present invention is also directed to a valve comprising an inlet port connectable to an upstream side of a fluid supply line, and an outlet port connectable to an downstream side of the fluid supply line; a control chamber extending between the inlet port and the outlet port and a sealing member disposed within said control chamber; said sealing member having an inlet sealing surface having a sealing surface area and a control portion having a control surface area; and a bleed aperture determining a minimal flow threshold through the control chamber; wherein the sealing member displaces between an open position and a closed position depending on a pressure differential over the sealing member.

A fluid supply system according to the concerned invention is suitable for use with gases or liquids and has a significant advantage of being inexpensive, reliable and suitable for easy retrofit installation on existing flow metering systems.

A further advantage of the device in accordance with the present invention is that it serves also as a one way valve preventing flow from a downstream direction to an upstream direction, i.e. from the consumer towards the supplier, in the case of a liquid supply system.

BRIEF DESCRIPTION OF THE DRAWINGS

In order to understand the invention and to see how it may be carried out in practice, some embodiments will now be described, by way of non-limiting examples only, with reference to the accompanying drawings, in which:

Fig. 1 is a schematic representation of a municipal water supply network fitted with a flow metering system according to the present invention;

Fig. 2 is a superimposed graph schematically illustrating the pressure and flow rate over time, in a water supply network fitted with a system according to the present invention;

Fig. 3 is a longitudinal section through a flow responsive valve according to an embodiment of the present invention, wherein:

Fig. 3A illustrates the valve in its open position; and

Fig. 3B illustrates the valve in its closed position;

Fig. 4 is a longitudinal section through a flow responsive valve according to another embodiment of the present invention, wherein:

Fig. 4A illustrates the valve in its open position; and

Fig. 4B illustrates the valve in its closed position;

Fig. 5 is a longitudinal section through a flow responsive valve according to still an embodiment of the present invention, wherein:

Fig. 5A illustrates the valve in its open position; and

Fig. 5B illustrates the valve in its closed position; and

DETAILED DESCRIPTION OF THE INVENTION

The present invention is suitable for implementation in a variety of fluid supply systems, however, for sake of sake of convenience and for exemplifying only, reference hereinafter is made to a water supply system, e.g. an urban/municipal water supply network.

Attention is first directed to Fig. 1 of the drawings schematically illustrating an end portion of an urban/municipal water supply system wherein an end user is for example a house, an office, a plant, etc. The house, in the present example, is

connected to a main water supply line designated **10** via a flow meter **12** with a suitable network of pipes **18** branching for example to a solar system **20**, wash basins **22**, toilets **26** and garden faucets **28**.

Each of the above end items, including the piping **18** is vulnerable to leaks owing to faulty sealing means (washers, gaskets, etc.), leaks in the piping, poor connections, etc.

In a water supply system not fitted with a device in accordance with the present invention, any such leaks which are below the minimal measurable flow threshold (a common such minimal threshold is about 10 liter/hour) would not be detected and would not be measurable, i.e. causing the water supplier considerable loss, not to mention the waste of fresh water which in some regions in the world is an acute problem.

In order to render a standard flow meter **12** capable of measuring also small amounts of water, there is installed a flow responsive valve generally designated **36**.. The valve 36 is sensitive to flow rate and pressure differential over its inlet and outlet ports, as will be explained hereinafter in more detail

The valve **36** is a normally closed valve which opens whenever an end device is opened for consumption of water, e.g. upon flushing the toilet **26** or the like, when the consumed rate exceeds the minimal measurable flow threshold. However, when there is no consumption of water by either of the end devices, the valve **36** spontaneously returns to its closed position. If a leak occurs at one or more locations along the piping **18** or at one or more of the end devices **20-28**, the flow responsive valve **36** remains closed whereby a pressure differential **ΔP** is being built between an inlet **40** connected upstream and an outlet **42** connected downstream. Such a pressure differential is built owing to the essentially constant pressure at the inlet **40** and the dropping pressure at outlet **42**. When the pressure differential **ΔP** reaches a predetermined threshold, the flow responsive valve **36** opens for a while, to allow water flow to the piping **18** until the valve reaches a pressure differential lower then a predetermined pressure threshold.

Fig. 2 is a superimposed graph schematically illustrating the pressure and flow rate over time, measured downstream of the flow responsive valve 36. The upper horizontal line represents the minimal measurable flow threshold of the metering device **12** whilst the lower horizontal line represents the flow consumption during a low flow consumption, e.g. owing to several leaks at the piping **18** and/or end devices **20-28** which are below the minimum measurable flow threshold of the metering device **12**. The graph represented by the letter **Q** represents the pulsating flow character through the flow meter where it is noticeable that flow is always above the minimum measurable flow threshold of the metering device **12** and operates in an on/off mode, i.e. all flow through the meter **12** is measurable. The line represented by the letter **P** illustrates the corresponding pressure in the system which also has a pulsating character.

Further attention will now be directed to several embodiments of a pressure sensitive valve in accordance with embodiments of the present invention by way of examples only. It is appreciated that many other embodiments are possible as well.

Turning now to Figs. 3A and 3B, reference is made to a valve generally designated **50** which in Fig. 3A is illustrated in its open position and in Fig. 3B is illustrated in its normally closed position. The valve **50** comprises a housing **52**, an inlet port **54** and an outlet port **56** both fitted for screw coupling to a pipe section (not shown) by suitable threadings **58** and **60**, respectively.

The valve is fitted with an inlet nozzle **62** having a diameter $\mathbf{D_i}$. A sealing member **64** is axially displaceable within the housing and is normally biased by means of coiled spring **66** into a normally sealed position, so as to seal the inlet nozzle **62** (Fig. 3B).

Sealing member **64** I fitted at an inlet end thereof with a resilient sealing portion **68** for improved sealing of the inlet nozzle **62**. Furthermore, and as noted in the figures, the housing **52** has a central bore slidingly supporting the sealing member **64**, said bore **70** having a diameter $\mathbf{D_b}$. Sealing member **64** has at an outlet end thereof a shoulder portion **74** having a predetermined tolerance with the

bore **70**, said tolerance determining a leak rate corresponding with the pulsating sequence imparted to the sequence, as discussed above.

Further noticeable, bore **70** is formed at an outlet side thereof with an expanded portion **80** of diameter $\mathbf{D_o}$.

The arrangement is such that when the valve **50** is in its open position, the shoulder portion **74** of the sealing member **64** reaches the expanded portion **80** to allow essentially free flow through the valve **50**.

The arrangement is such that the biasing force **Fs** of the spring **66** is predetermined whereby the valve **50** remains in its closed position as long as the pressure differential ΔP does not exceed a predetermined pressure determined by the diameter ratios of $\mathbf{D_i}$ and **Fs** and the pressure at the inlet port **54** and outlet port **56**.Thus, the force required to open the valve is determined by $\mathbf{Fs<\Delta P*A(D_i)}$, where $\mathbf{A(D_i)}$ is the surface area at the inlet nozzle **62**. Similarly, the valve will close when $\mathbf{\Delta P<Fs/A(D_o)}$, where $\mathbf{A(D_o)}$ is the surface area at the expanded portion **80**. it is also apparent that the pressure differential required for closing the valve is lower then that required for generating a pulse in the system, this being since $\mathbf{D_i<D_o}$

The arrangement is such that when the pressure differential over the inlet port and outlet port is smaller than a predetermined threshold, the valve **50** remains sealed since the only force acting is the biasing force **Fs** of spring **66**. However, when pressure at the outlet port **56** drops (e.g. upon a leak at the piping of the system or at one of the end devices, as discussed hereinabove) and there the inlet pressure at inlet port **54** remains essentially constant, the pressure differential over the valve increases and the sealing member **64** will displace into its open position as in Fig. 3A.

Furthermore, it is appreciated that the shoulders **74** of the sealing member **64** take the role in retaining the sealing member in the open position under a pressure differential. It is further appreciated that the tolerance between the diameter of the shoulder **74** and the bore **70** in fact determines the pulsating timing, as it determines a so-called leak rate of the system.

Further attention is now directed to Figs. 4A and 4B in which a valve **80** is principally similar to the valve discussed hereinabove in connection with Figs. 3A and 3B and accordingly, reference is made only to the differing element which is the shape of the shoulder **84** of the sealing member **86** and the corresponding change in shape of the expanded portion **88** of the cylindric bore **90** of the housing. The purpose of this particular design is to give rise to a narrow flow path **91** when the valve is in its open position as in Fig. 4, to thereby give rise to an increased flow velocity and at the path **90**, generating a force acting in the direction of arrow **92** (Fig. 4A) namely in the direction to assist in displacing the sealing member **86** into an open position, contrary to the force imparted by coiled spring **94**. This is obtained by local increase of flow velocity causing ;ow static pressure down stream, thus decreasing the head loss.

The design of Figs. 4A and 4B renders the valve **80** more significant open/closed position to avoid undefined positions and scattering of the valve at near to equilibrium position.

Figs. 5A and 5B illustrate still another embodiment of a pressure sensitive valve in accordance with the present invention generally designated **100** wherein the sealing force is imparted by magnetic means, rather than by a coiled spring as in the previous embodiment.

As can be seen in Figs. 5A and 5B, the housing comprises an inlet segment **104** formed with an inlet port **106**, and an outlet segment **108** fitted with an outlet port **110**, both said inlet and said outlet being fitted with a suitable threading for coupling to a pipe segment (not shown).

Outlet segment **108** is formed adjacent the inlet segment **104** with a tapering portion **114** and with a stopper member **116**. A sealing member **120** being a metallic sphere **122** coated with a resilient layer **124**, has a diameter larger than the narrow most portion of the tapering wall **114** and similarly, the diameter of the sealing member **120** is larger than the gaps **130** of barrier member **116**. The arrangement is such that the sealing member **120** is displaceable within the housing between a closed position (Fig. 5B) wherein it sealingly engages the tapering wall

portion **114**, and an open position (Fig. 5A) wherein it disengages from the tapering portion **114** to allow free flow through the valve **100**.

The biasing force is imparted on the sealing member **120** by means of the magnetic inlet member **104** acting on the steel core **122** of sealing member **120** into sealing engagement with the narrow most portion of the tapering wall portion **114**.

The valve in accordance with the embodiment of Figs. 5A and 5B operates in a similar manner as discussed in connection with the valves of Figs. 3 and 4 and the reader's attention is directed thereto.

A further advantage of the device 36 in accordance with the present invention, is that it serves also as a one way valve preventing flow from a downstream direction (i.e. from the consumer) to an upstream direction (i.e. towards the supplier). This feature is of particular importance e.g. in connection with a water supply system and serves to prevent flow of contaminated water towards the supplier in case of a flood or burst in supply pipes, where there is risk of mud and dirt entering the system and flowing upstream and possibly contaminating water reservoirs and harming equipment of the water supplier.

It is appreciated that the above embodiments are merely example of valves suitable for use with a metering system and method as disclosed above and many other such valves may be designed, all of which fall within the scope of the invention.

CLAIMS:

1. A fluid metering system comprising a fluid supply line and a fluid meter for measuring fluid flow therethrough, said meter having a minimum measuring flow threshold; the system further comprising a valve having an inlet port and an outlet port; said valve shiftable between an open position at flow rates above its minimum measurable flow threshold, and a pressure pulsating position depending on pressure differential over its ports, said pressure pulsating position altering between a closed position essentially prohibiting fluid flow therethrough at flow rates below the minimum measuring flow threshold, and an open position admitting fluid flow into the supply line at a measurable flow rate above the minimum measuring flow threshold.

2. A fluid metering system according to Claim 1, wherein the valve is a normally closed pressure controlled valve.

3. A fluid metering system according to Claim 1, wherein the valve is fitted adjacent before or after the fluid meter.

4. A fluid metering system according to Claim 1, wherein the valve is integrated with the fluid meter.

5. A fluid flow metering method according to Claim 1, wherein portions of the supply line and devices fitted thereon, downstream of said pressure controlled valve, act as a fluid accumulator.

6. A fluid metering system according to Claim 1, wherein the system is a liquid supply network.

7. A fluid metering system according to Claim 6, wherein the system is a municipal water supply network.

8. A fluid metering system comprising a meter for measuring fluid flow and having a minimum measuring flow threshold; the system further comprising a flow responsive valve having an open position admitting fluid flow only at a flow rate above the minimum measuring flow threshold, and a closed position substantially restricting fluid flow at flow rates below the measuring threshold.

9. A fluid metering system comprising a fluid supply line and a meter for measuring fluid flow therethrough, said meter having a minimum measuring flow threshold; the system further comprising a flow responsive valve imparting the system with a flow pattern having a pulsating character so as to substantially prohibit flow at a flow rate below the minimum measuring threshold, and resume flow of only measurable quantities of fluid.

10. A fluid metering system according to Claim 9, wherein the flow responsive valve is shiftable between an open position whenever pressure differential over an inlet port and an outlet port thereof exceeds a minimum pressure threshold, to thereby admit fluid flow at a flow rate above the minimum measuring flow threshold, and a closed position substantially prohibiting fluid flow therethrough.

11. A method according to claim 1, wherein the valve is a one way valve, preventing flow in an upstream direction.

12. A method for metering fluid flow through a fluid supply line comprising a flow meter having a minimum measurable threshold and a flow responsive valve imparting a flow pattern therethrough with a pulsating character so as to substantially restrict flow at a flow rate below the minimum measuring threshold, and resume flow of only measurable quantities of fluid.

13. A fluid flow metering method according to Claim 12, wherein average fluid flow through the system remains constant over time, wherein the average fluid flow through the supply line remains constant over time flow rate fluctuations imparted by the system according to the present invention are not acknowledgeable.

14. A fluid flow metering method according to Claim 12, wherein the flow responsive valve is fitted adjacent to or integrally with the flow meter.

15. A fluid flow metering method according to Claim 12, wherein portions of the supply line and devices fitted thereon, downstream of said pressure controlled valve, act as a fluid accumulator.

16. A valve comprising an inlet port connectable to an upstream side of a fluid supply line, and an outlet port connectable to an downstream side of the fluid supply line; a control chamber extending between the inlet port and the outlet port

and a sealing member disposed within said control chamber; said sealing member having an inlet sealing surface having a sealing surface area and a control portion having a control surface area; and a bleed aperture determining a minimal flow threshold through the control chamber; wherein the sealing member displaces between an open position and a closed position depending on a pressure differential over the sealing member.

17. A valve according to Claim 16, being a normally closed flow responsive valve and wherein the sealing member is biased into sealing engagement of the inlet port.

18. A valve according to Claim 17, wherein the sealing member is spring biased into sealing engagement of the inlet port.

19. A valve according to Claim 17, wherein the sealing member is magnetically biased into sealing engagement of the inlet port.

20. A valve according to Claim 19 wherein the sealing member comprises a ferromagnetic member and a housing of the device is fitted with a fixed magnetic biasing member, to thereby bias the sealing member into sealing engagement of the inlet port.

21. A valve according to Claim 20, wherein the sealing member is coated with a resilient material.

A valve according to Claim 16, for imparting a fluid supply line with a pulsating fluid flow pattern, extending between a sealed position and an open position, and wherein the average fluid flow through the supply line remains constant over time flow rate fluctuations imparted by the system according to the present invention are not acknowledgeable.

22. A valve according to Claim 16, wherein the sealing surface area is smaller than the control surface area.

23. A valve according to Claim 16, wherein the bleed aperture is an interstice between a housing of the device and the control portion.

24. A valve according to Claim 17, wherein a flow restriction is formed at the open position, so as to increase flow speed at a downstream side of the sealing

member, to thereby give rise to a force in a direction opposed to a sealing force acting on the sealing member.

25. A valve according to claim 24, wherein the surface area is a cylindrical bore of the housing of the valve; the bore is formed with an expansion and the sealing member is formed with a tapering portion corresponding with the expansion, thereby giving rise to head loss when the sealing member displaces into an open position, so as to increase opening force of valve.

26. A valve according to claim 16 being a one way valve, preventing flow in an upstream direction.

27. A flow responsive valve for a flow metering system comprising a fluid meter having a minimum measuring flow threshold; said valve being shiftable between an open position at flow rates above the minimum measuring flow threshold, and a pressure pulsating position depending on pressure differential over its ports, said pressure pulsating position altering between a closed position essentially prohibiting fluid flow therethrough at flow rates below the minimum measuring flow threshold, and an open position admitting fluid flow into the supply line at a measurable flow rate above the minimum measuring flow threshold.

For the Applicants,
REINHOLD COHN AND PARTNERS
By:

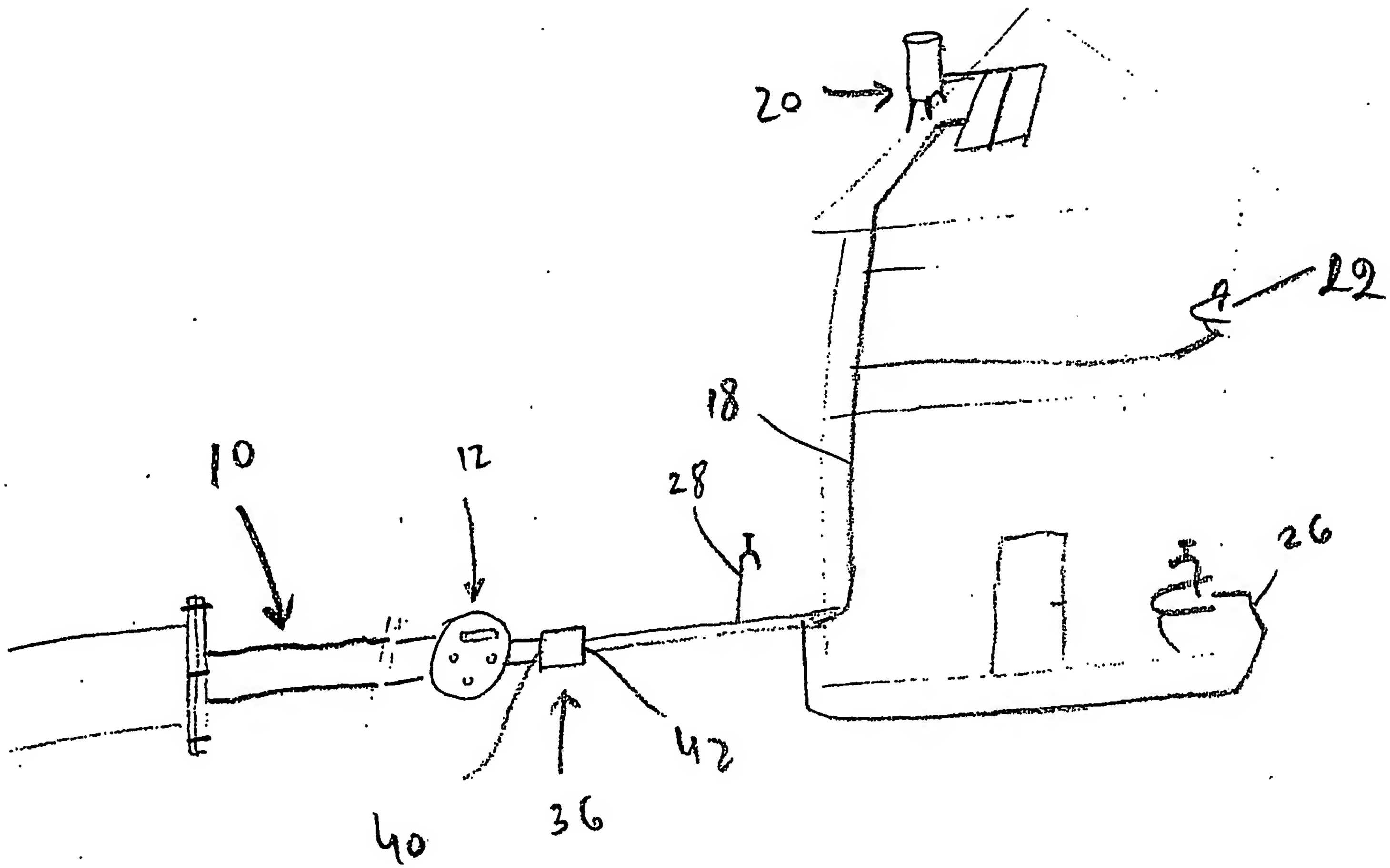
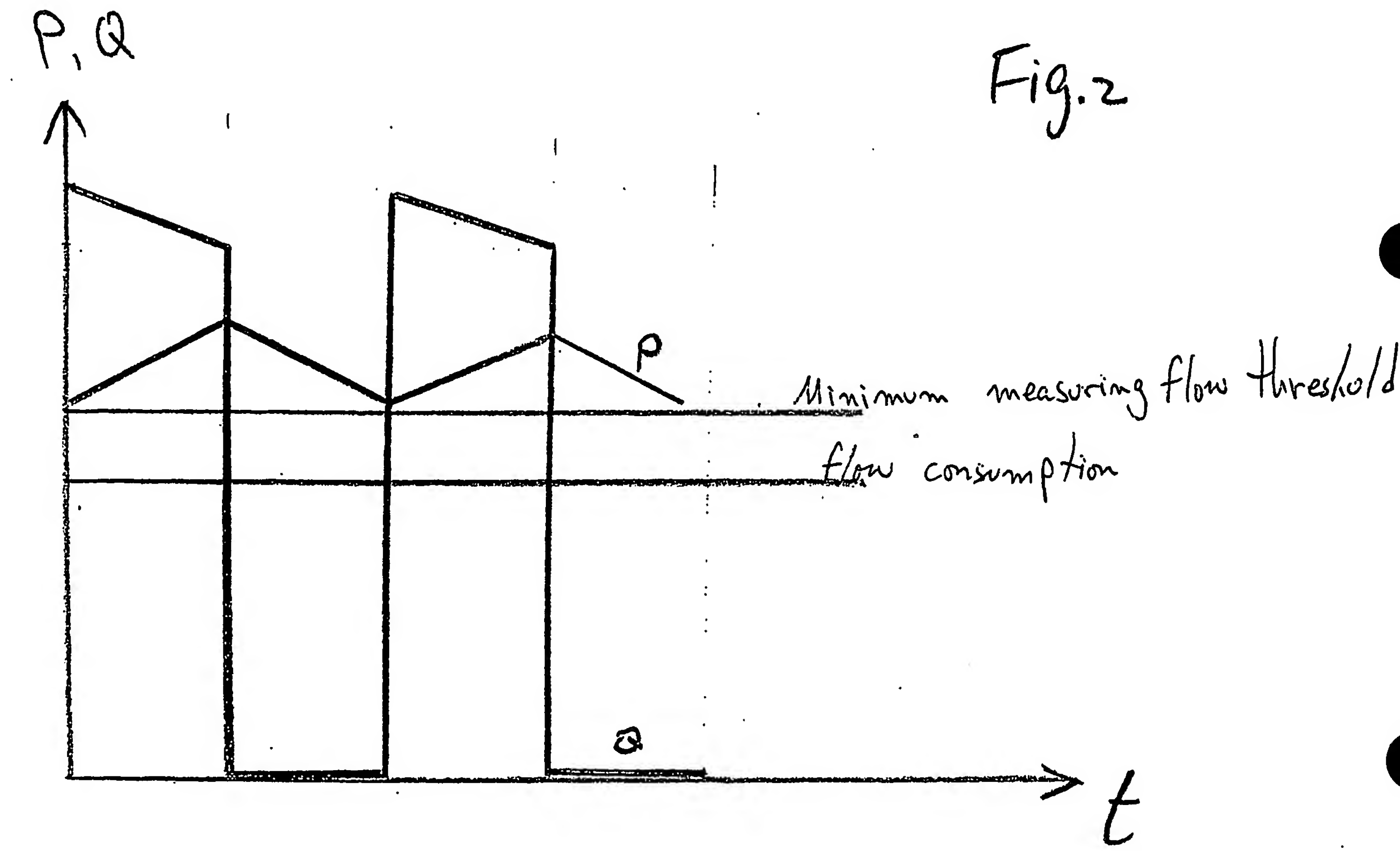


Fig. 1

Fig.2



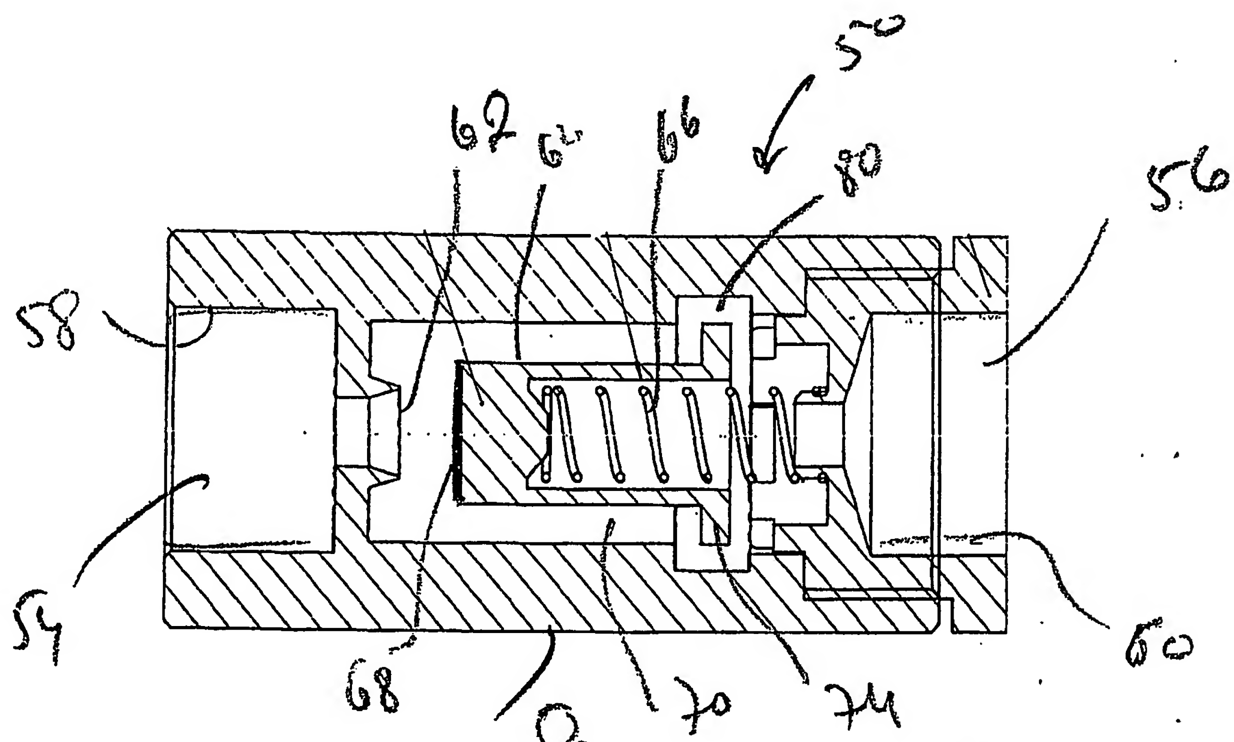

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Fig. 3A

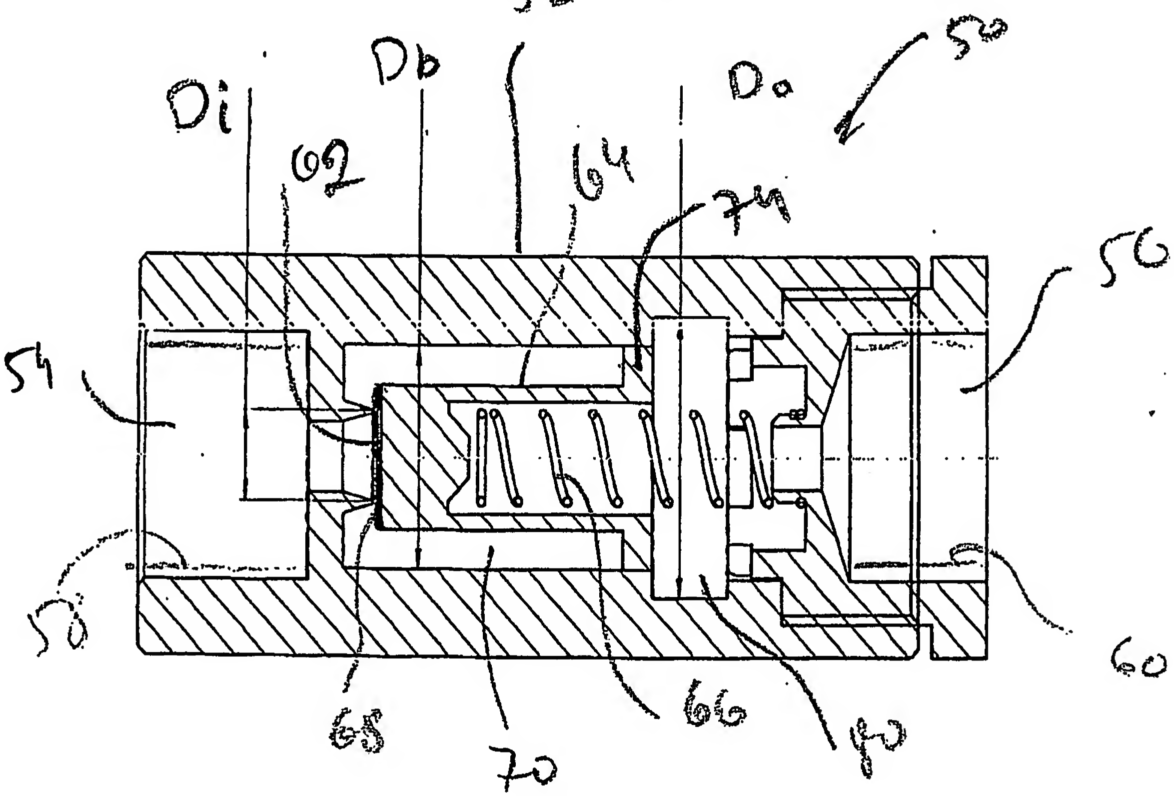
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Fig. 3B

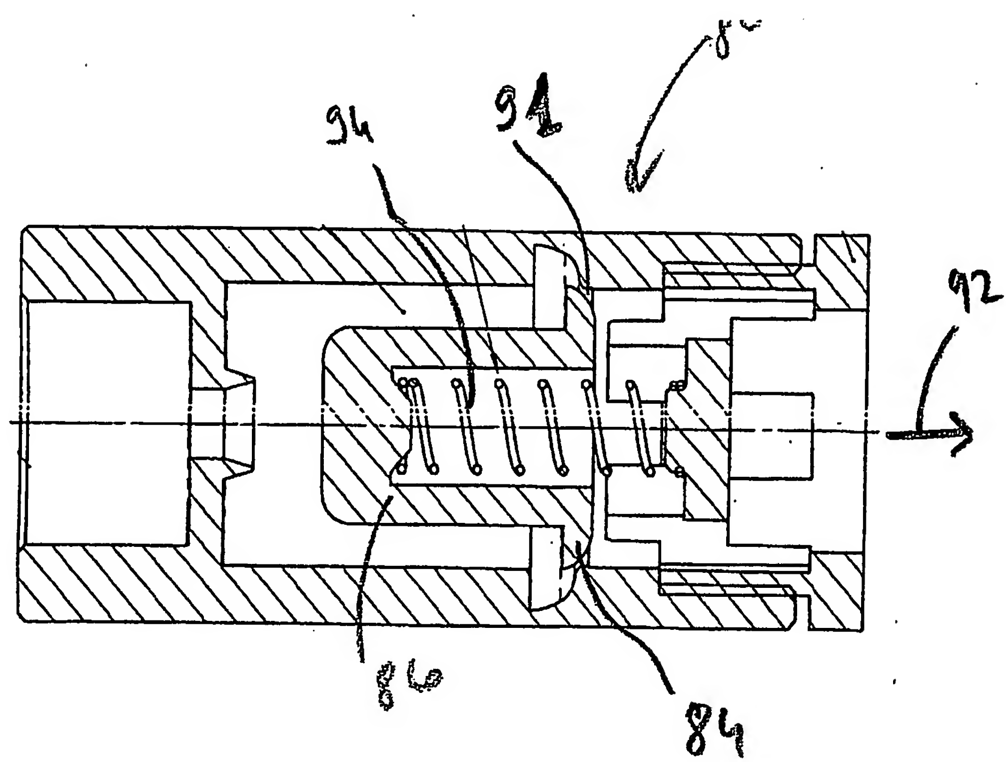

Fig 4A

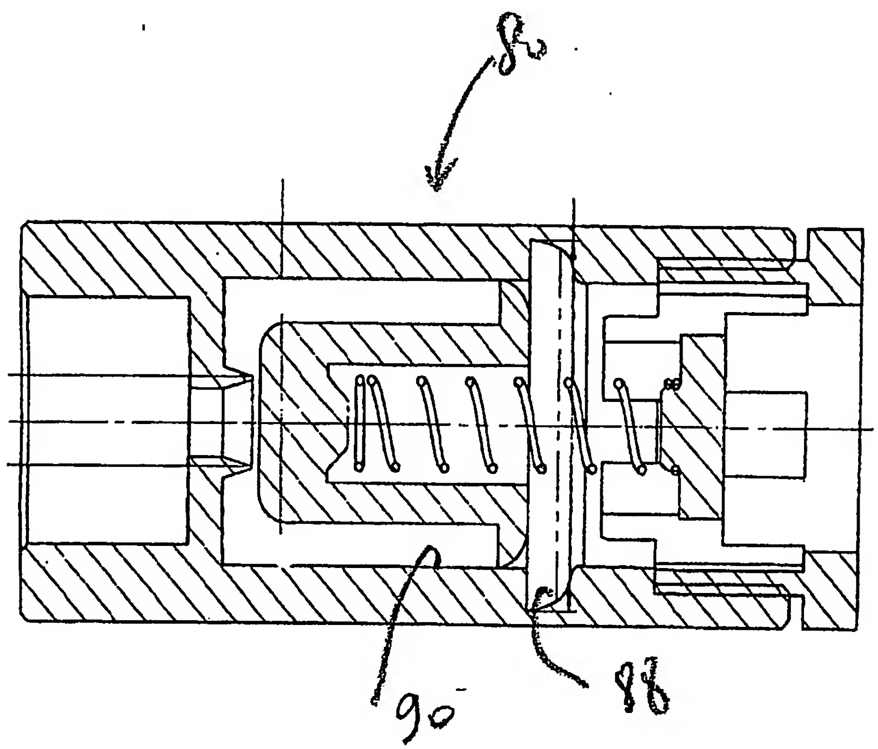

Fig 4B

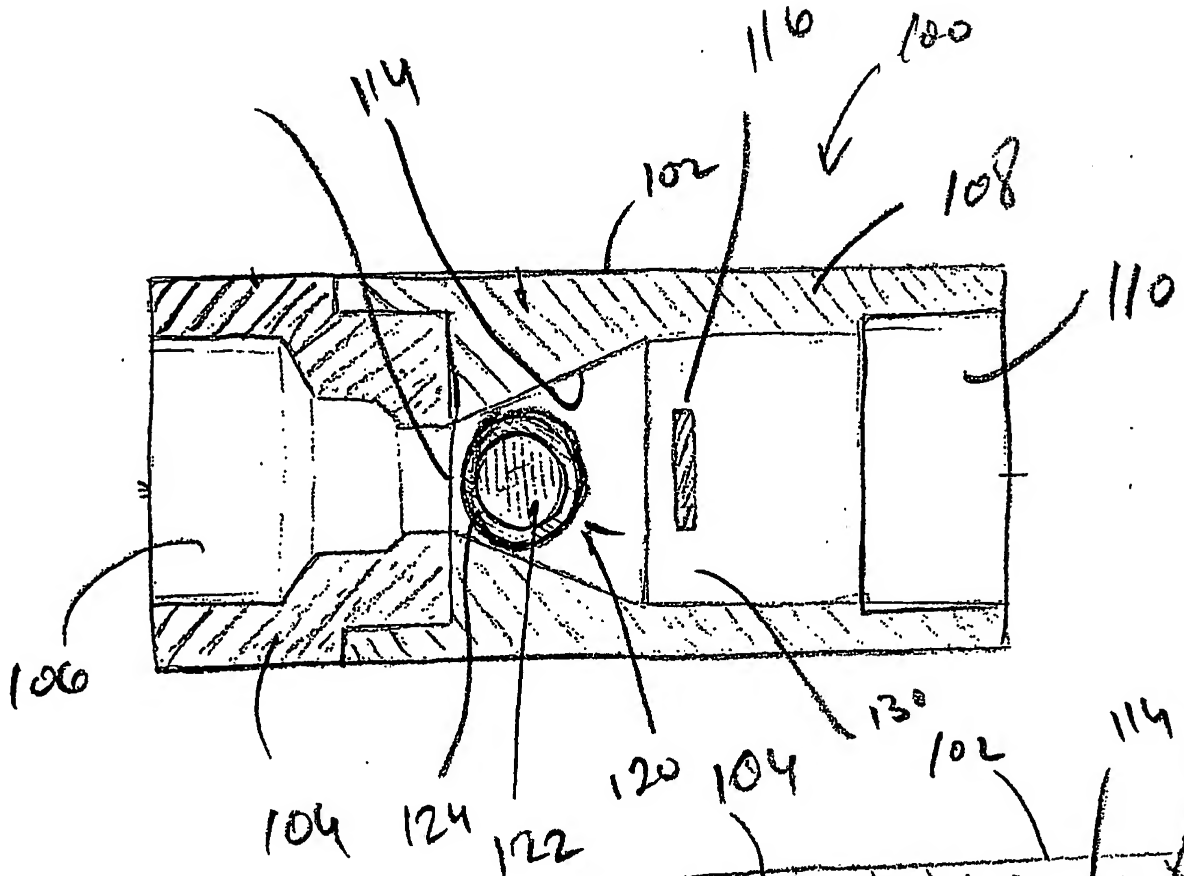
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Fig. 5B

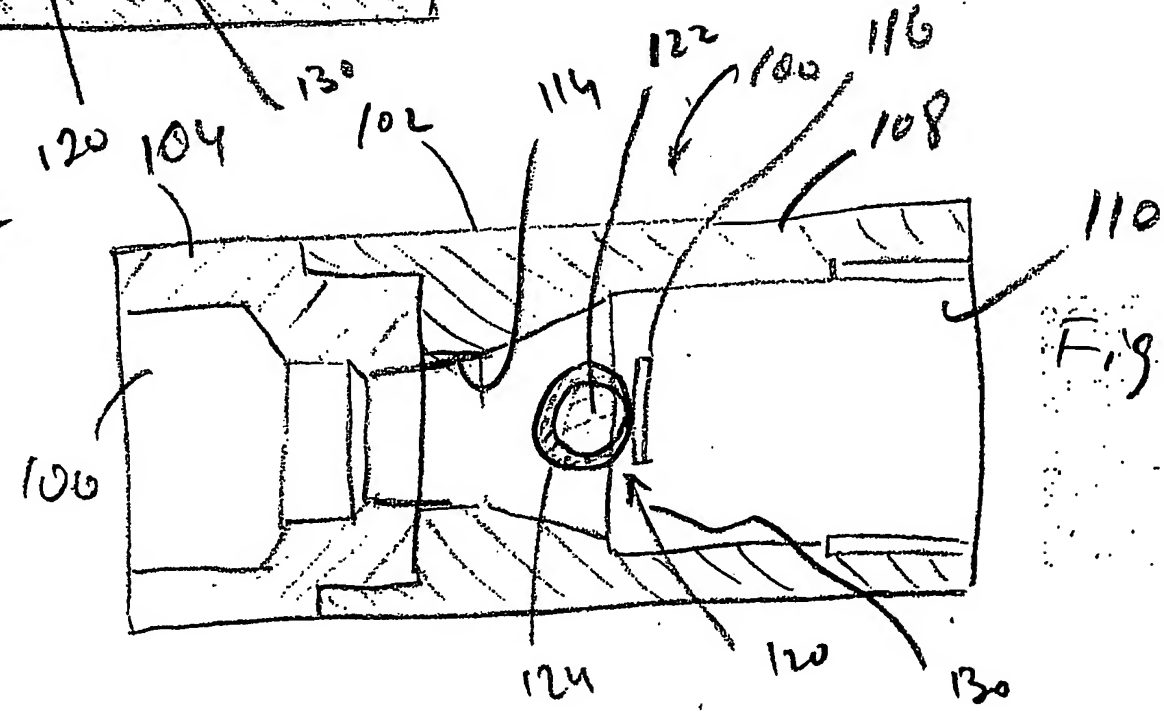
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Fig. 5A